

Application Serial No. 10/655,939

Reply to Office Action Dated 03/07/2005

In the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A magnetic detecting element comprising:

a multilayer laminate including a first antiferromagnetic layer, a pinned magnetic layer, a nonmagnetic material layer, and a free magnetic layer deposited in that order from below;

a nonmagnetic interlayer disposed above the free magnetic layer;

a pair of first ferromagnetic layers disposed above the nonmagnetic interlayer in end portions in a track width direction of the magnetic detecting element, the first ferromagnetic layers being separated in the track width direction by a space therebetween;

a pair of second antiferromagnetic layers separately disposed above the respective first ferromagnetic layers;

a pair of second ferromagnetic layers separately disposed above the respective second antiferromagnetic layers; and

electrode layers,

wherein the pair of second antiferromagnetic layers have respective outer end portions with a distance therebetween larger than the distance between the pair of first ferromagnetic layers in the track width direction, and respective internal end portions with a distance therebetween smaller than the distance between the outer end portions in the track width direction, the internal end portions jutting from internal end surfaces of the respective outer end portions toward a central portion in the track width direction, wherein the internal end portions have a thickness that is smaller than that of the outer end portions, the pair of antiferromagnetic layers have an internal end portion starting at the space between the first ferromagnetic layers and extending outward in a track width direction, the internal end portion having a substantially constant thickness for a non-zero length prior to a gradual increase in thickness at an outer end portion of the second antiferromagnetic layer such that at least two distinct points on the same side of the space have the same thickness in the internal end portion, and

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wherein a magnetization direction of the second ferromagnetic layers is antiparallel to that of the first ferromagnetic layers.

2. (Previously Presented) A magnetic detecting element according to Claim 1, wherein the pair of electrode layers lies over the internal end portions of second antiferromagnetic layers.

3. (Previously Presented) A magnetic detecting element according to Claim 2, wherein the second ferromagnetic layers lie over the internal end portions and the outer end portions of the second antiferromagnetic layers.

4. (Previously Presented) A magnetic detecting element according to Claim 2, wherein the second ferromagnetic layers overlie only the outer end portions of the second antiferromagnetic layers.

5. (Previously presented) A magnetic detecting element according to Claim 1, the second ferromagnetic layers comprise a soft magnetic material and are deposited directly on upper surfaces of the second antiferromagnetic layers.

6. (Previously presented) A magnetic detecting element according to Claim 5, wherein a magnetic moment per area of the free magnetic layer is larger than that of the first ferromagnetic layers.

7. (Original) A magnetic detecting element according to Claim 1, further comprising nonmagnetic layers between the respective second antiferromagnetic layers and the second ferromagnetic layers, wherein the second ferromagnetic layers comprise a hard magnetic material.

8. (Previously presented) A magnetic detecting element according to Claim 1, further comprising nonmagnetic layers between the respective second antiferromagnetic layers and the second ferromagnetic layers, and third antiferromagnetic layers on respective upper surfaces of the second ferromagnetic layers, wherein the second ferromagnetic layers comprise a soft magnetic material.

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9. (Original) A magnetic detecting element according to Claim 8, wherein the first antiferromagnetic layers, the second antiferromagnetic layers, and the third antiferromagnetic layers comprise the same material.

10. (Previously presented) A magnetic detecting element according to Claim 8, wherein the third antiferromagnetic layers comprise a material having a blocking temperature lower than that of the materials of the first antiferromagnetic layers and the second antiferromagnetic layers.

11. (Previously presented) A magnetic detecting element according to Claim 7, wherein a magnetic moment per area of the free magnetic layer is larger than that of the first ferromagnetic layers.

12. (Previously presented) A magnetic detecting element according to Claim 7, wherein a magnetic moment per area of the free magnetic layer is smaller than that of the first ferromagnetic layers.

13. (Canceled)

14. (Original) A magnetic detecting element according to Claim 1, wherein the electrode layers lie above and under the multilayer laminate.

15. (New) A magnetic detecting element comprising:

- a multilayer laminate including a first antiferromagnetic layer, a pinned magnetic layer, a nonmagnetic material layer, and a free magnetic layer deposited in that order from below;

- a nonmagnetic interlayer disposed above the free magnetic layer;

- a pair of first ferromagnetic layers disposed above the nonmagnetic interlayer in end portions in a track width direction of the magnetic detecting element, the first ferromagnetic layers being separated in the track width direction by a space therebetween;

- a pair of second antiferromagnetic layers separately disposed above the respective first ferromagnetic layers;

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a pair of second ferromagnetic layers separately disposed above the respective second antiferromagnetic layers;

electrode layers; and

nonmagnetic layers disposed between the respective second antiferromagnetic layers and the second ferromagnetic layers, and third antiferromagnetic layers on respective upper surfaces of the second ferromagnetic layers,

wherein a magnetization direction of the second ferromagnetic layers is antiparallel to that of the first ferromagnetic layers,

the second ferromagnetic layers comprise a soft magnetic material, and

the first antiferromagnetic layers, the second antiferromagnetic layers, and the third antiferromagnetic layers comprise the same material.

16. (New) A magnetic detecting element comprising:

a multilayer laminate including a first antiferromagnetic layer, a pinned magnetic layer, a nonmagnetic material layer, and a free magnetic layer deposited in that order from below;

a nonmagnetic interlayer disposed above the free magnetic layer;

a pair of first ferromagnetic layers disposed above the nonmagnetic interlayer in end portions in a track width direction of the magnetic detecting element, the first ferromagnetic layers being separated in the track width direction by a space therebetween;

a pair of second antiferromagnetic layers separately disposed above the respective first ferromagnetic layers;

a pair of second ferromagnetic layers separately disposed above the respective second antiferromagnetic layers;

electrode layers; and

nonmagnetic layers disposed between the respective second antiferromagnetic layers and the second ferromagnetic layers, and third antiferromagnetic layers on respective upper surfaces of the second ferromagnetic layers,

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wherein a magnetization direction of the second ferromagnetic layers is antiparallel to that of the first ferromagnetic layers,

the second ferromagnetic layers comprise a soft magnetic material, and

the third antiferromagnetic layers comprise a material having a blocking temperature lower than that of the materials of the first antiferromagnetic layers and the second antiferromagnetic layers.